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Financial Modeling for Net Present Benefit Analysis of Electric Bus and Diesel Bus and Applications to NYC, LA, and Chicago

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Abstract : Transportation is one of the leading sources of greenhouse gas emissions (GHG). Thus, to meet the Paris Agreement 2015, all countries must adopt a different and more sustainable transportation system. From bikes to Maglev, the world is slowly shifting to sustainable transportation. To develop a utility public transit system, a sustainable web of buses must be implemented. As of now, only a handful of cities have adopted a detailed plan to implement a full fleet of e-buses by the 2030s, with Shenzhen in the lead. Every change requires a detailed plan and a focused analysis of the impacts of the change. In this report, the economic implications and financial implications have been taken into consideration to develop a well-rounded 10-year plan for New York City. We also apply the same financial model to the other cities, LA and Chicago. We picked NYC, Chicago, and LA to conduct the comparative NPB analysis since they are all big metropolitan cities and have complex transportation systems. All three cities have started an action plan to achieve a full fleet of e-bus in the decades. Plus, their energy carbon footprint and their energy price are very different, which are the key factors to the benefits of electric buses. Using TCO (Total Cost Ownership) financial analysis, we developed a model to calculate NPB (Net Present Benefit) /and compare EBS (electric buses) to DBS (diesel buses). We have considered all essential aspects in our model: initial investment, including the cost of a bus, charger, and installation, government fund (federal, state, local), labor cost, energy (electricity or diesel) cost, maintenance cost, insurance cost, health and environment benefit, and V2G (vehicle to grid) benefit. We see about $1,400,000 in benefits for a 12-year lifetime of an EBS compared to DBS provided the government fund to offset 50% of EBS purchase cost. With the government subsidy, an EBS starts to make positive cash flow in 5th year and can pay back its investment in 5 years. Please remember that in our model, we consider environmental and health benefits, and every year, $50,000 is counted as health benefits per bus. Besides health benefits, the significant benefits come from the energy cost savings and maintenance savings, which are about $600,000 and $200,000 in 12-year life cycle. Using linear regression, given certain budget limitations, we then designed an optimal three-phase process to replace all NYC electric buses in 10 years, i.e., by 2033. The linear regression process is to minimize the total cost over the years and have the lowest environmental cost. The overall benefits to replace all DBS with EBS for NYC is over $2.1 billion by the year of 2033. For LA, and Chicago, the benefits for electrification of the current bus fleet are $1.04 billion and $634 million by 2033. All NPB analyses and the algorithm to optimize the electrification phase process are implemented in Python code and can be shared.

Keywords : financial modeling, total cost ownership, net present benefits, electric bus, diesel bus, NYC, LA, Chicago
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